May 11, 1965 W. JUPTNER 3,182,382

METHOD OF MAKING SEALED SWITCHES

Original Filed Aug. 14, 1957 2 Sheets-Sheet 1

FIG. 2

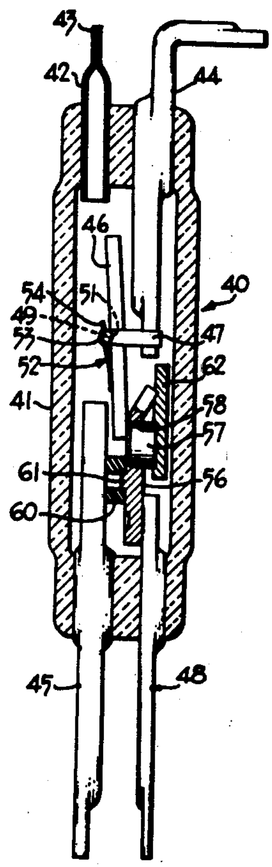

FIG. 1

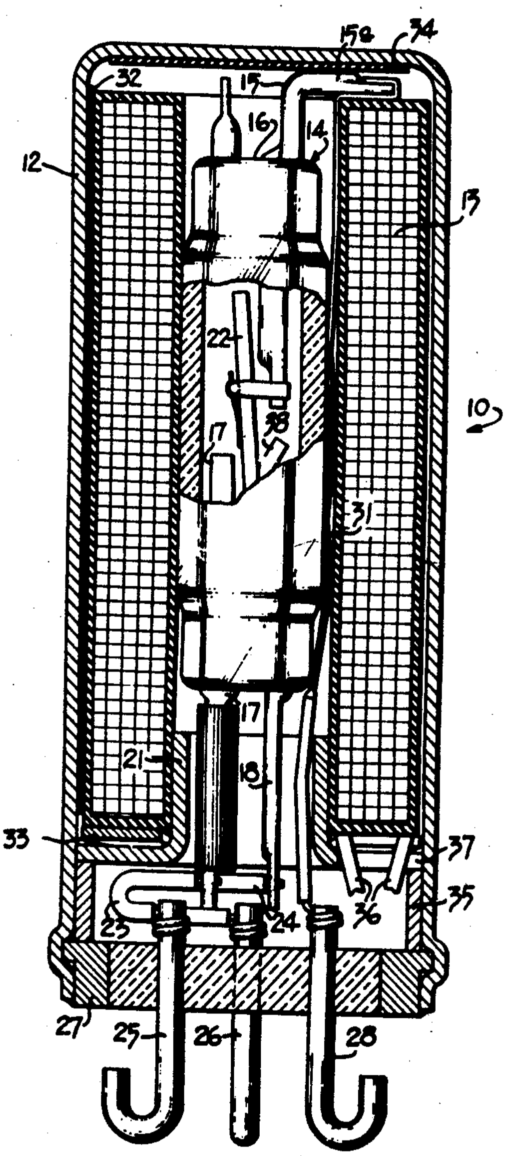

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FIG. 3

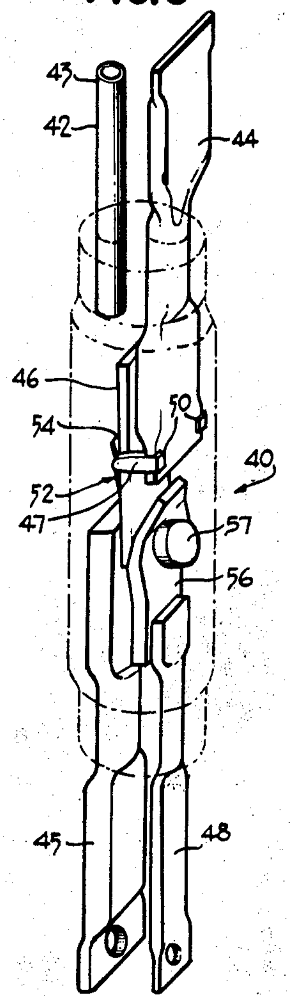


FIG. 4

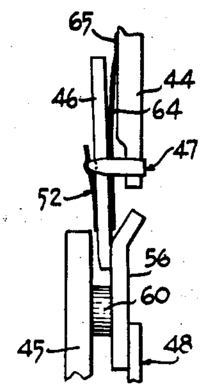


FIG. 5

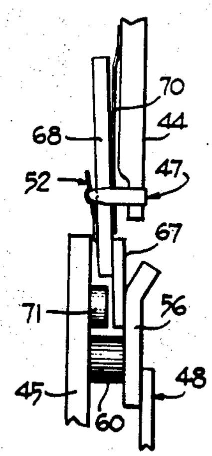
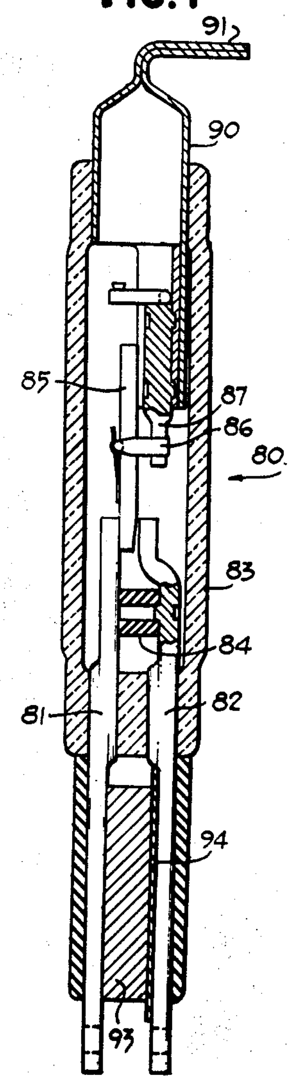


FIG. 7



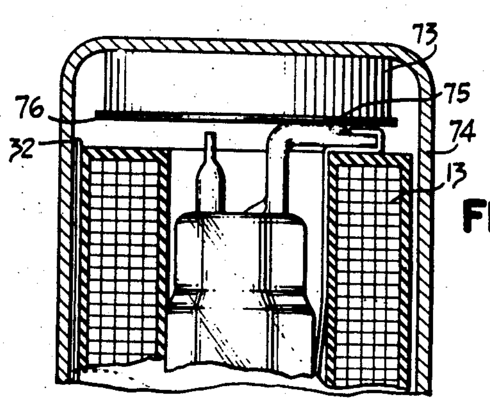


FIG. 6

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1

3,182,382
METHOD OF MAKING SEALED SWITCHES
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Original application Aug. 14, 1957, Ser. No. 678,236, now Patent No. 3,033,956, dated May 8, 1962. Divided and this application Sept. 7, 1961, Ser. No. 136,590
9 Claims. (Cl. 29—155.55)

This invention relates to a method of making switching devices and, more particularly, to a method of assembling a sealed switch unit having a pivotally mounted armature. The present application is a division of a copending application Serial No. 678,236, filed August 14, 1957, now Patent No. 3,033,956.

One object of the present invention is to provide a new and improved method of assemblying sealed switch units.

Another object is to provide a method of making a sealed switch unit having a magnetic armature pivotally mounted on one of a plurality of magnetic terminals sealed within a dielectric housing.

Briefly, the above and further objects are realized in accordance with the present invention by providing a switching unit comprising as its principal elements a balanced, pivotally mounted armature and two or more electrically conductive terminal members which extend from the switching unit, at least two of the terminals being ferromagnetic so as to function as pole pieces as well as electric terminals. This sealed switch is constructed by sealing one magnetic terminal in one end of an elongated dielectric housing, inserting the armature and pivotally mounting it on the one terminal, and then mounting another terminal in the open end of the housing and sealing this other terminal in the housing.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view, partially in section, of a relay embodying certain aspects of the present invention;

FIG. 2 is a perspective view showing the switching unit of the relay illustrated in FIG. 1;

FIG. 3 is a fragmentary perspective view of a switching unit embodying the present invention;

FIGS. 4 and 5 are fragmentary side elevational views of switching units embodying other aspects of the present invention;

FIG. 6 is a fragmentary side elevational view of the upper portion of a relay embodying certain aspects of the present invention; and

FIG. 7 is a side elevational view of a relay switching unit embodying certain aspects of the present invention.

Referring now to the drawings and more particularly to FIG. 1 thereof, there is shown a complete relay **10** which comprises as its principal elements a generally cylindrical housing or can **12** in which is mounted a control winding or coil **13** and a hermetically sealed switching unit or cartridge **14**. In the unit **14**, a ferromagnetic electrically conductive terminal and heel piece **15** protrudes from the top of a hermetically sealed glass housing **16** from the bottom of which extend two terminal members **17** and **18**. The terminal **17** is ferromagnetic so that it also functions as a heel piece. The members **15** and **17** thus cooperate with the can **12** and a tubular ferromagnetic sleeve **21** to provide a stator having an air gap in which a balanced ferromagnetic and electrically conductive armature **22** is pivotally mounted for selectively connecting the terminal member **15** to either the terminal member **17** or the terminal member **18**.

2

The terminals **17** and **18** are respectively connected through conductors **23** and **24**, to two terminal pins **25** and **26**. These terminal pins are conventionally mounted in a disk-shaped header **27** which is formed of insulating material and is secured in place, as shown, to close the bottom opening in the can **12**. A third terminal pin **28** extends through the header **27** and is electrically connected to the upper terminal member **15** by means of a resilient wave shaped connector **31** of rectangular cross-section, which also functions to bias the switching unit **14** against the opposite side of the inner wall of the coil **13**, thereby to eliminate any radial play between the switching unit **14** and the coil **13**.

Radial play between the coil **13** and the housing **12** is prevented by means of a plurality of elongated resilient and folded inserts **32** which are positioned between the coil **13** and the inner wall of the housing **12**. Axial movement of the coil **13** with respect to the housing **12** is prevented by means of a washer **33** which is interposed between the sleeve **21** and the lower end of the coil **13** and has one or more resilient pretensioned crimps therein for resiliently biasing the coil **13** upward against the bottom surface of the off-turned portion of the terminal **15**. The terminal **15** is thus resiliently urged against an insulating disk **34** positioned at the top of the housing **12**. The flanged sleeve **21** is supported within the housing **12** by means of a tubular sleeve **35** which is interposed between the sleeve **21** and the header **27**. The pretensioned washer **33** thus not only acts to force the terminal member **15** to the top of the can **12** but also acts to bias the sleeve **21** and the sleeve **35** toward the header **27**, thereby to prevent relative movement of the switching unit **14** either with respect to the winding **13** or with respect to the can **12**. The winding **13** is provided with a pair of input leads **36** which extend through a suitable slot **37** in the sleeve **21** and are respectively connected to terminal pins (not shown) which extend through and are supported by the header **27**.

Considering the operation of the relay of FIG. 1, let it be assumed that the armature **22** is normally biased by means not visible in the drawing into engagement with a nonmagnetic contact member **38** which is welded to the terminal member **18** so that when no current is supplied to the coil **13** the armature is positioned in the manner illustrated in FIG. 1 and electrically connects the terminal **15** to the terminal **18**. Accordingly, the terminal pins **26** and **28** are interconnected within the relay **10**.

When a current of sufficient value is supplied to the windig **13** to operate the relay **10**, a magnetic field is establishd which causes flux traversal of the magnetic circuit. This circuit extends from the top portion of the winding **13** through the bent-over portion **15***a* of the terminal member **15**, through the terminal member **15** to the armature **22** across the air gap between the lower portion of the armature **22** and the upper portion of the terminal member **17**, through the terminal member **17**, across the relatively short gap to the sleeve **21**, through the sleeve **21** and the walls of the can **12** back to the bent-over portion **15***a* of the terminal member **15**. The magnetic flux which is thus caused to traverse the gap between the armature **22** and the terminal **17** causes the armature **22** to pivot clockwise so that the amature **22** engages the terminal **17**. When this occurs, the terminal pins **25** and **28** are interconnected and the terminal pin **26** is disconnected from the terminal pin **28**. Upon termination of the supply of current to the winding **13**, the armature **22** pivots counterclockwise under the influence of the biasing force exerted thereon to its normal position in which the terminal pins **26** and **28** are connected.

Referring now more particularly to FIGS. 2 and 3, the details of a sealed switching unit or cartridge **40** of the side stable type are there illustrated. Briefly, this unit comprises a hermetically sealed housing 41, preferably formed of glass, which may either be evacuated or filled with a suitable arc suppressing gaseous medium at a desired pressure through a tube 42 which opens into the housing and is pinched off at its upper end 43 after the desired atmosphere has been established in the housing 41. A set of ferromagnetic, electrically conductive terminals 44, 45 and 48 respectively extend through the upper and lower ends of the housing 41 and facilitate connection of the unit 40 in the electrical and magnetic circuits of the relay. A balanced armature 46 is pivotally mounted on the terminal 44 and selectively connects it to either of the terminals 45 and 48.

As best shown in FIGS. 2 and 3, the armature 46 is pivotally mounted on a ferromagnetic and electrically conductive supporting structure 47 which is attached to the lower end of the terminal 44. The support 47 comprises a pair of side members 50 which are received in suitable recesses at the sides of the terminal member 44 and between the ends of which extends a cylindrical pivot bar 51. The armature 46 is attached to the support 47 by means of a cantilever type of spring or spring element 52 which has its lower end secured, as by welding or the like, to the armature 46 and may be provided with a semi-cylindrical upper end portion 53 which is adapted to engage the bar 51 and which is positioned opposite a semi-cylindrical recess 49 in the armature 46. In initially mounting the armature 46 upon the support 47, which has previously been attached to the terminal 44, the left-hand surface of the armature 46, as viewed in FIG. 2, is slid along the right-hand edge of the pivot bar 51 so that as the off-turned upper end 54 of the spring 52 engages the bar 51 the upper end of the spring 52 moves toward the left away from the body of the armature 46 to cause the spring to ride over the bar 51 until the depression 53 and the recess 49 are aligned with the bar, at which time the spring 52 snaps toward the right, thereby pivotally to attach the armature 46 to the support 47. Since the supporting posts 50 and the bar 51 are formed of ferromagnetic material, they are magnetically connected to the terminal 44. Therefore, when a magnetic field is established between the terminals 44 and 45, the armature 46 pivots clockwise into engagement with the upper portion of the terminal 45 thereby to establish a conductive path between the terminals 44 and 45.

In the arrangement shown in FIGS. 2 and 3, the armature 46 is biased into engagement with the terminal 48 by means of a small cylindrically shaped permanent magnet 57 which is mounted in a recess 58 in the rear surface of a nonmagnetic contact 56 supported upon the terminal 48. In order to maximize the ratio of the flux path reluctance of the terminal 48 to that of the terminal 45, the nonmagnetic contact 56, such, for example, as silver, is welded to the upper end of the terminal 48. The spacing between the contact portions of the terminals 45 and 48 is established by means of a nonmagnetic insulating spacer sleeve 60 which partially surrounds a cylindrical boss on the front side of the nonmagnetic contact member 56. The length of the spacer 60 thus determines the length of the air gap between the armature 46 and the terminal 45 and thus the air gap flux density required to operate the relay against the attractive force of the permanent magnet 57.

It may thus be seen that the magnet 57 biases the armature 46 in its limiting counterclockwise position as shown in FIG. 2. If an increased biasing force is desired, a magnetic yoke 62 may be attached to the back of the magnet 57 so that the upper portion of the yoke 62 is in proximity to the lower end of the terminal 44 thereby to provide a low reluctance magnetic circuit for the biasing magnet 57 which extends through the yoke 62 across the gap to the terminal 44, through the support 47 and back to the opposite pole of the magnet 57 through the lower half of the armature.

Bounce suppression during snap return of the armature to its biased position is obtained by the magnetic attraction of armature 46 to the permanent magnet 57. When the relay operates and the armature rotates clockwise to strike the terminal 45, bounce is prevented by the strong magnetic field which exists between the armature 46 and the contact 45 to which it is directly connected.

In assembling the parts of the switching unit 40, the terminal 44 with the support 47 mounted thereon and the tube 42 are first sealed into the upper end of the tubular glass housing 41. This assembly operation is performed with the lower end of the housing fully open. The armature 46 is next inserted into the housing through the open lower end thereof and pivotally mounted upon the pivot bar 51 of the support 47 in the manner described above. The terminal 48 with the parts 56, 57 and 62 mounted thereon, and the terminal 45 are next inserted into the open lower end of the housing 41 until they are brought into the desired positions relative to the terminal 44 and the armature 46. During this positioning operation, the terminals 45 and 48 are fixedly held in their desired relative positions with the spacer 60 positioned therebetween. When the parts 41, 44, 45, 46, and 48 are thus correctly positioned relative to each other and while being held in their correct relative positions, the lower end of the tubular housing 41 is sealed off to complete the assembly. Finally, the interior of the housing is evacuated or filled with a suitable arc suppressing gas through the tube 42 after which this tube is pinched off and sealed.

Referring now to FIG. 4, an alternative embodiment of a portion of the switching unit is there shown, wherein a spring or resilient element 64 is used to bias the armature into engagement with the nonmagnetic contact member 56. Since this embodiment is a modification of the switching unit 40, similar parts are designated by like reference numbers. As shown, the armature 46 is magnetically and electrically mounted on the common terminal 44 by means of the support 47 and the spring 52. The armature 46 is shown in its normal position in engagement with the forward face of the nonmagnetic contact member 56 which is spaced from the magnetic terminal member 45 by means of the spacer sleeve 60. A preformed spring 64 having a pretensioned resilient off-turned end portion 65 is secured at its lower end, as by spot welding or the like, to the armature 46 and the upper end thereof bears against the forward face of the terminal 44 to bias the armature 46 in a counterclockwise direction into engagement with the contact member 56. It should be noted that as the armature 46 is released and pivots counterclockwise, the off-turned portion 65 of the spring 64 slides downwardly against the face of the terminal 44 as the armature 46 moves into contact with contact 56 on terminal 48.

Referring to FIG. 5 an alternative embodiment of the invention is there shown which constitutes a modification of the spring biased armature arrangement shown in FIG. 4. The unit of FIG. 5 is particularly suitable for use in handling heavy switching currents and thus includes a relatively large area contact 67 which is attached as by spot welding to the lower end of the principal body portion of an armature 68. The armature 68 is pivotally supported on the terminal 44 by means of the support 47 and the spring 52 and the contact 67 is biased against the nonmagnetic contact member 56 by means of a biasing spring or resilient element 70 which is attached at its lower end to the armature 68. As shown, the armature 68 is pivoted at a point approximately at its center of gravity, thus providing a balanced armature which requires a minimum of current in the control winding to effect operation of the relay. Also, a large area contact button 71 is mounted on the terminal member 45 for electrical engagement with the contact member 67 of the armature 68 when the relay is operated. The thickness of the contact member 71 exceeds that of the armature 68 so that a residual gap is provided between the armature 68 and the terminal 45 when the relay is operated.

Referring now to FIG. 6, there is shown the upper portion of a relay embodying an alternative aspect of the invention and which includes a permanent magnet 73 disposed in the upper portion of a ferromagnetic housing or can 74 to provide a permanent magnetic field across the air gap in the associated switching unit (not shown). The magnet 73 is wedged between an upper terminal 75 and the top of the can 74 and since the terminal member 75 is both a part of the magnetic circuit and an electrical conductor connected in the external switching circuit, an insulating disk 76 is positioned between the magnet 73 and the terminal member 75 to maintain the can 74 isolated from the electrical circuits. Therefore, by using the cartridge 40 in the embodiment of FIG. 6, the relay may be biased toward an operate or release position depending upon the polarity of the magnet 73. More specifically, with the magnet 73 polarized in one direction, more current of a particular polarity must flow through the winding 13 to effect operation of the armature from its released position to its operated position, whereas if the magnet 73 is polarized in the opposite direction, a lesser current flow of the same polarity through the winding 13 is required to overcome the normal armature bias and effect operation of the armature to its operated position.

Referring now to FIG. 7, a bistable, polar switching unit 80 is there shown. This unit comprises a set of ferromagnetic terminal members 81 and 82 which extend through and are sealed to the bottom of the housing 83 and are spaced apart by a nonconductive spacer sleeve 84 located within the housing. The unit 80 also includes an armature 85 pivotally mounted on a support 86 which is attached to a common terminal member and heel piece 87. The terminal 87 is electrically and magnetically connected to a ferromagnetic and conductive tube 90 which extends from the upper end of the housing 83 and which is pinched off and bent over at its upper end 91 to seal the housing and to provide the off-turned upper end of the terminal for use in conjunction with the coil and associated structure as shown, for example, in FIG. 1. A permanent magnet 93 is disposed outside the housing 83 between the lower portions of the terminals 81 and 82 and is insulated from the terminal 82 by means of a nonmagnetic insulating spacer 94. The magnet is polarized in a direction from right-to-left and serves to bias the armature 85 in either of its limiting positions in contact with either of the terminals 81 or 82.

The unit 80 may be used in a side stable relay by using it in conjunction with the embodiment shown in FIG. 6 which includes the permanent magnet 73. Depending upon the polarities of the magnets 73 and 93, the flux densities produced by each across the air gaps between the armature 85 and the terminals 81 and 82 will be in opposition in one instance and in aiding relationship in the other. Consequently, the armature 85 is biased so as to close the latter air gap. In such a side stable relay, properly polarized current in the relay winding overcomes the magnetic field of the magnets 73 and 93, thereby causing the relay to operate. There is thus provided a side stable polar relay from which the biasing spring has been eliminated.

While the invention has been described in connection with particular embodiments thereof, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A method of assembling a switching unit of the type comprising a plurality of terminals respectively extending from opposite ends of a tubular housing and a magnetic armature pivotally secured to one of said terminals, the armature and at least one of the terminals including contact portions selectively movable into and

out of engagement with each other, which comprises sealing said one terminal in one end of said housing, inserting the armature into said housing and pivotally securing it to said one terminal, thereafter inserting the other of said terminals into the end of said housing opposite said one end with a portion of the other terminal overlapping and spaced from a portion of the armature, and sealing said other terminal to said housing.

2. The method set forth in claim 1 in which the one terminal carries a pivot structure and the armature carries a flat spring secured at one end to the armature, and in which the step of pivotally securing the armature to the one terminal includes inserting the pivot structure between the armature and the free end of the flat spring so that the flat spring forces the pivot structure and the armature together to pivotally secure these two elements.

3. A method of making a sealed switch unit from a length of glass tubing, two magnetic terminals, and a magnetic armature, the armature and at least one of the terminals having contact portions movable into and out of engagement with each other, which method comprises disposing a first magnetic terminal in the opening at one end of said tubing, heating said tubing to close said one end of said tubing and to rigidly mount said first terminal on said tubing, inserting said magnetic armature into said tubing through the open other end thereof, pivotally mounting the magnetic armature on said one terminal, disposing the second of said magnetic terminals in the open other end of said tubing with a portion of the second magnetic terminal overlapping but spaced from a portion of the magnetic armature, and heat sealing the other end of said tubing to seal said other end of said tubing and rigidly mount said second terminal on said housing.

4. A method of making a sealed switch unit including an elongated dielectric housing having an axially extending opening with opposite open ends, first and second magnetic terminals, a magnetic armature, a spring element, and a pivot structure, the armature and the second terminal having contact portions movable into and out of engagement with each other, which method comprises the steps of securing the pivot structure to one end of said first terminal, disposing the first terminal in the opening at one end of said housing with the pivot structure located within the housing and projecting toward the center of said opening, heat sealing said one end of said housing to close said end and rigidly mount said first terminal on said housing, securing said spring element to said armature, inserting said armature into said opening through the other open end, moving said armature to force said pivot structure between said armature and said spring element to pivotally mount said armature on said first terminal, disposing said second terminal in said other open end of said housing with at least a portion of the second terminal in an overlapping but normally spaced relation with at least a portion of the armature, and heat sealing said other end of said tubing to close said other end and rigidly mount said second terminal on said housing.

5. The method set forth in claim 4 in which the step of disposing the first terminal in the opening at one end of said housing includes disposing said first terminal to one side of the axis of said opening, in which the steps of inserting and moving said armature includes disposing said armature generally at a position extending along the axis of said opening, and in which the step of disposing said second terminal in the opening at the other open end of said housing includes positioning said second terminal on the other side of the axis of said opening opposite said one side.

6. A method of making a sealed switch unit from a length of glass tubing, two magnetic terminals, a magnetic armature, and a generally U-shaped pivot structure, the magnetic armature and at least one of the magnetic terminals having contact portions selectively movable

into and out of engagement with each other, which method comprises securing the U-shaped pivot structure to a first magnetic terminal adjacent one end of the first magnetic terminal, disposing the first magnetic terminal in one end of the tubing with the pivot structure within the tubing, heating the one end of the tubing to seal the first terminal, inserting the magnetic armature into the tubing through the other open end and pivotally mounting it on the pivot structure with the armature disposed between the bight of the U-shaped pivot structure and the adjacent portion of the first terminal, positioning the second magnetic terminal in the other end of the tubing, and heating the other end of the tubing to seal the second terminal.

7. A method of making a sealed switch unit from a length of dielectric tubing, a magnetic armature, and two magnetic terminals, one of which carries a pivot structure, the magnetic armature and at least one of the magnetic terminals including contact portions selectively movable into and out of engagement with each other, which method comprises disposing the first magnetic terminal in one end of the tubing with the pivot structure within the tubing, sealing the one end of the tubing to rigidly support the first terminal, inserting the magnetic armature into the tubing through the other open end and mounting it on the pivot structure with at least a portion of the armature disposed adjacent the first terminal, positioning the second magnetic terminal in the other end of the tubing with a portion of the second terminal spaced from and overlapping at least a portion of the armature, and sealing the other end of the tubing to rigidly support the second terminal.

8. A method of making a sealed switch unit from a hollow dielectric housing, two magnetic terminals, a magnetic armature, a resilient spring means, and a pivot structure, the magnetic armature and at least one of the magnetic terminals including contact portions movable into and out of engagement with each other, which method comprises mounting the pivot structure on a first magnetic terminal adjacent one end of the first magnetic terminal, disposing the first magnetic terminal in one end of the housing with the pivot structure within the housing, sealing the first terminal in the one end of the housing, mounting the resilient spring means on the armature, inserting the magnetic armature into the housing through the other open end and pivotally mounting it on the pivot structure with the resilient spring means interposed between the armature and the first terminal to bias the armature, positioning the second magnetic terminal in the other end of the housing with a portion of the second terminal spaced from and overlapping at least a portion of the armature, and sealing the second terminal in the other end of the housing.

9. A method of making a sealed switch unit from a length of glass tubing, two magnetic terminals, a magnetic armature, a resilient spring means, and a generally U-shaped pivot structure, the magnetic armature and at least one of the magnetic terminals having contact portions movable into and out of engagement, which method comprises securing the U-shaped pivot structure to a first magnetic terminal adjacent one end of the first magnetic terminal, disposing the first magnetic terminal in one end of the tubing with the pivot structure within the tubing, heating the one end of the tubing to seal the first terminal, securing one end of the resilient spring means to the armature, inserting the magnetic armature into the tubing through the other open end and pivotally mounting it on the pivot structure with the armature disposed between the bight portion of the U-shaped pivot structure and the adjacent portion of the first terminal and with the resilient spring means engaging the first terminal, positioning the second magnetic terminal in the other end of the tubing with a portion spaced from and overlapping part of the armature, and heating the other end of the tubing to seal the second terminal.

References Cited by the Examiner

UNITED STATES PATENTS

2,397,123	3/46	Brown	200—87
2,459,306	1/49	Burton	200—87
2,706,756	4/55	Brewer	200—87

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